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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

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REPLY TO THE ATTENTION OF:

SRF-5J

Mr. Johnny W. Reising
United States Department of Energy
Feed Materials Production Center
P.O. Box 398705
Cincinnati, Ohio 45239-8705

RE: Vitrification Melter Incident: Final Report

Dear Mr. Reising:

The United States Environmental Protection Agency (U.S. EPA) has completed its review of the United States Department of Energy's (U.S. DOE) vitrification Pilot Plant melter incident: final report.

This document provides the results of investigations conducted by the safety review team, the data analysis and path forward teams, and the incident analysis review team.

Overall the report provides an adequate assessment of the team's findings. U.S. EPA has attached some general comments regarding the final report.

When considering future vitrification activities, U.S. EPA believes the following design recommendations should be considered.

U.S. DOE should design and build another prototype, pilot-scale melter at the site. This pilot-scale melter should be designed to process K-65 residue and should be able to be upgraded to full-scale operation. Experience with the high-level waste vitrification program at the U.S. DOE Savannah River Site has shown that the most serious secondary effects, such as ammonium nitrate and hydrogen formation, were only observed at the pilot plant scale because an extensive testing program was conducted that involved processing of actual residues. DOE's current path forward for vitrification of Silo 1 and 2 residues involves design and construction of full-scale modules based on information obtained from laboratory-scale and minimelter-scale using actual waste material or off-site pilot plant-scale operations using surrogate material. This approach will likely be extremely costly and poses an unacceptable risk of failure. Small-scale or off-site pilot plant-scale operations may not provide adequate process information for the full-scale design, and numerous design modifications are likely to be required to achieve full-scale operations.



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The design should be based on current furnace designs used for mass production of glass and should incorporate standard glass industry practices of using low-cost, replaceable construction materials and standard brick shapes for the refractory material. The glass melter should be designed as a refractory-lined process vessel. The recommended configuration for glass melters is a cylindrical shell with hemispherical heads to minimize stresses and distribute them uniformly. U.S. DOE should avoid straight-wall designs because of the greater risk of failure of the straight-wall construction when subjected to severe thermal stresses. DuPont Corporation has had many years of success in operating refractory-lined process vessels with cylindrical shells and hemispherical heads.

Containment of the glass is the highest priority, and confinement for a potential spill of molten glass should be designed and built into the configuration of the melter. No penetrations in the vessel wall should be permitted below the glass melt line. Therefore, the electrodes should be installed through the upper sidewall or top head. In the event that molten glass begins to migrate through the refractory, the glass should be frozen in the refractory and not permitted to penetrate to the insulation layer.

Additional design considerations include the following: the refractory should be locked in place with keystone construction; the outside surface of the vessel shell should be water-cooled; and if molybdenum disilicide material is used, it should be treated as a consumable material.

Please contact me at (312) 886-0992 if you have any questions regarding this matter.

Sincerely,

James A. Saric
Remedial Project Manager
Federal Facilities Section
SFD Remedial Response Branch #2

Enclosure

cc: Tom Schneider, OEPA-SWDO
Bill Murphie, U.S. DOE-HDQ
John Bradburne, FERMCO
Charles Little, FERMCO
Terry Hagen, FERMCO
Tom Walsh, FERMCO

# TECHNICAL REVIEW COMMENTS ON "VITRIFICATION PILOT PLANT (VITPP) MELTER INCIDENT: FINAL REPORT" FERNALD ENVIRONMENTAL MANAGEMENT PROJECT (FEMP) FERNALD, OHIO

## GENERAL COMMENTS

Commenting Organization: U.S. EPA Commentor: Saric
Section #: Attachment B Page #: Not applicable (NA) Line #: NA
Original General Comment #: 1
Comment: The text indicates that the project safety documentation did not adequately address the safety concerns raised by the continual operational problems with the melter components. In an effort to continue melter operations, the U.S. Department of Energy (DOE) ignored a number of warning signs of impending melter failure. In addition, monitoring activities intended to detect corrosion, reducing and oxidizing conditions, and material breakdown were not routinely performed. These deficiencies should be addressed in future Fernald Environmental Management Project (FEMP) melter design, operation, and monitoring plans. Moreover, DOE should have an independent team of professionals from the glass and waste vitrification industries review project safety documents, operational safety procedures, and monitoring requirements for any future vitrification plants to be installed at FEMP.

Commenting Organization: U.S. EPA Commentor: Saric
Section #: Attachment C Page #: NA Line #: NA
Original General Comment #: 2
Comment: Based on the complex chemical characteristics of the materials in Silos 1 and 2 and on the difficulties encountered with the vitrification process and the off-gas treatment system during VITPP operations, the technical justification for vitrifying the residues from Silos 1 and 2 should be re-evaluated. Specifically, DOE should perform a chemical analysis of the Silo 1 and 2 residues to determine whether the sulfate present takes the form of barium sulfate, calcium sulfate, lead sulfate, or magnesium sulfate throughout the silos. Making this determination is a critical step in the decision-making process because of the varying volatilization rates of the different types of sulfates and the questionable feasibility of vitrifying residues containing various types of sulfates, particularly if a low-heat glass formula is used.

In addition, DOE should reconsider solidification as a treatment alternative for Silo 1 and 2 residues. Radon, the major isotope in the residues, can be controlled by solidification, which is the treatment process used for low-level thorium wastes at FEMP. Compared to vitrification, solidification has the added advantages of lower cost, greater simplicity, and greater processing efficiency. Since solidification is the likely treatment process for Silo 3 residues, the inclusion of Silo 1 and 2 residues may be cost effective. In any case, DOE should conduct a streamlined evaluation of all alternatives for treatment of Silo 1 and 2 residues.

Commenting Organization: U.S. EPA Commentor: Saric
Section #: Attachment C Page #: NA Line #: NA
Original General Comment #: 3
Comment: If DOE is to proceed with the treatment alternative involving vitrification of Silo 1 and 2 residues, an independent team of professionals from the glass and waste vitrification industries should review the design package.

Commenting Organization: U.S. EPA Commentor: Saric
Section #: Attachment C Page #: NA Line #: NA
Original General Comment #: 4
Comment: Two issues associated with the path forward data collection process are critical to the evaluation of the treatment alternative involving vitrification of Silo 1 and 2 residues. One issue concerns the glass chemistry of the actual waste, and the other involves treatment of off-gas.

The glass chemistry studies performed by the Catholic University of America and the Vitreous State Laboratory indicate that the sulfate in the Silo 1 and 2 residues takes the form of calcium sulfate, which decomposes at about 1,400 °C, and barium sulfate, which decomposes at 1,580 °C. If this is true, then the low-heat (1,150 °C) glass formula may not remove the sulfate from the glass. DOE should perform a chemical analysis of the Silo 1 and 2 residues to determine whether the sulfate present takes the form of barium sulfate, calcium sulfate, lead sulfate, or magnesium sulfate throughout the silos. Making this determination is a critical step in the decision-making process because of the varying volatilization rates of the different types of sulfates and the questionable feasibility of vitrifying residues containing sulfates with varying volatilization rates.

Off-gas treatment is an important issue because of the potential problems associated with pluggage and carryover. Pluggage and carryover in off-gas treatment have been a problem at most of the vitrification facilities. Actual waste will not be used in pilot-plant scale testing, but the problems associated with pluggage and carryover will likely occur during full-scale module testing. DOE should describe how these specific problems with off-gas treatment will be addressed.

Commenting Organization: U.S. EPA Commentor: Saric
Section #: Attachment C Page #: NA Line #: NA
Original General Comment #: 5
Comment: Use of several full-scale modules as verification steps before processing actual waste appears to be an expensive way to confirm the melter design. It may be more cost-effective to design and operate a prototype, pilot-scale melter in which actual K-65 residue would be used. The melter could then be coupled to the material handling system in order to verify the efficiency of the overall vitrification process.

Commenting Organization: U.S. EPA Commentor: Saric
Section #: Attachment C Page #: NA Line #: NA
Original General Comment #: 6
Comment: The text refers to an operations readiness preparation estimated to cost $4,500,000 that would be conducted for a refabricated VITPP at FEMP. This cost is extremely high considering the operations readiness exercises already undertaken for the original VITPP. DOE should provide a justification for the cost estimated for the operations readiness preparation for reusing the modified VITPP at FEMP.

Commenting Organization: U.S. EPA Commentor: Saric
Section #: Attachment C Page #: NA Line #: NA
Original General Comment #: 7
Comment: The text refers to monolith testing being reconsidered for evaluation of devitrification. Subsequent testing plans should specify the procedures to be used for collecting representative samples of the monoliths, the analytical methods to be used, and the associated quality control requirements.

Commenting Organization: U.S. EPA Commentor: Saric
Section #: Attachment C Page #: NA Line #: NA
Original General Comment #: 8
Comment: The path forward involving vitrification at OU4 will likely require a close support laboratory to provide quick turnaround analytical results for operating parameters (for example, redox conditions). Oxidation and reduction were not monitored well and this contributed to FEMP overlooking the corrosion of the refractory. DOE should address how it will monitor key operating parameters.